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REVIEWS

The Association for Symbolic Logic publishes analytical reviews of selected books and articles in the field of symbolic logic. The reviews were published in ***The Journal of Symbolic Logic*** from the founding of the JOURNAL in 1936 until the end of 1999. The Association moved the reviews to this BULLETIN, beginning in 2000.

The Reviews Section is edited by Alasdair Urquhart (Managing Editor), Steve Awodey, John Baldwin, Lev Beklemishev, Mirna Džamonja, David Evans, Erich Grädel, Denis Hirschfeldt, Roger Maddux, Grigori Mints, Luke Ong, Volker Peckhaus, and Sławomir Solecki. Authors and publishers are requested to send, for review, copies of books to *ASL, Box 742, Vassar College, 124 Raymond Avenue, Poughkeepsie, NY 12604, USA.*

In a review, a reference "JSL XLIII 148," for example, refers either to the publication reviewed on page 148 of volume 43 of the JOURNAL, or to the review itself (which contains full bibliographical information for the reviewed publication). Analogously, a reference "BSL VII 376" refers to the review beginning on page 376 in volume 7 of this BULLETIN, or to the publication there reviewed. "JSL LV 347" refers to one of the reviews or one of the publications reviewed or listed on page 347 of volume 55 of the JOURNAL, with reliance on the context to show which one is meant. The reference "JSL LIII 318(3)" is to the third item on page 318 of volume 53 of the JOURNAL, that is, to van Heijenoort's *Frege and vagueness*, and "JSL LX 684(8)" refers to the eighth item on page 684 of volume 60 of the JOURNAL, that is, to Tarski's *Truth and proof*.

References such as 49***5*** or 280***1*** are to entries so numbered in *A bibliography of symbolic logic* (the JOURNAL, vol. 1, pp. 121–218).

MARK BURGIN. ***Super-recursive algorithms.*** Monographs in Computer Science, Springer, New York, 2005, xiv + 304 pp.

This is a truly extraordinary book. The author notes that " … the majority of program properties related to their output are undecidable by … modern computers when they work in the recursive mode." But he assures us that " … superrecursive algorithms can solve many of such problems for ordinary programs and contemporary computers." In the author's brave new world, "Recent development[s] … allowed researchers to overcome limitations of Church-Turing thesis, discovering superrecursive algorithms and explicating hypercomputation. … Higher computing power means that superrecursive algorithms can solve such problems that no recursive algorithm … can solve in principle." Among the author's astonishing predictions is the following: " … constructive inductive Turing machines represent functioning of modern and future computers and networks; hierarchies of such machines allow one to … prove all true sentences in the formal first order arithmetic in contrast to the famous Gödel incompleteness theorem, … " Mathematicians can eagerly await the proofs of the Goldbach Conjecture and the Riemann Hypothesis that this amazing technology promises!

Burgin finds a key to what he regards as the limitations of "recursive algorithms" in their being formulated in terms of an input yielding an output after which the machine stops. In contrast "superrecursive algorithms" can model a situation in which the computer continues indefinitely. (Burgin seems to be unaware of the fact that in Turing's original paper, his

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machines did in fact continue indefinitely.) Burgin's initial example of an "inductive" Turing machine is one that will produce a sequence of outputs that will eventually stabilize as the desired result. The sets accepted by such machines are (the extensions of) the "trial and error" predicates of Gold and Putnam, well known to be precisely the Δ_2^0 sets. Burgin's inductive Turing machines generalize this notion extending their reach through the entire arithmetic hierarchy. It is a pity that he doesn't stop to tell us how he imagines this power could be realized in real-world physical devices.

These inductive machines are the subject of some of Burgin's own work, but this book is not limited to his own work. He places himself enthusiastically in the company of the "hypercomputation" movement. Hava Siegelmann claims that her "neural nets" with arbitrary real numbers as weights go beyond what she calls the "Turing limit." They certainly do: her nets not only accept uncomputable sets, in fact they accept **all** sets of strings on a given alphabet. They accomplish this feat by having the set to be accepted coded into a real number weight of one of their "neurons." Burgin also includes Turing machines with oracles among his superrecursive algorithms. "Oracles" that were supposed to provide answers to questions about membership in non-computable sets were introduced by Turing in his dissertation for purely mathematical purposes. However, Jack Copeland managed to see in Turing's work an implied proposal for the physical realization of such an oracle, and seriously urged it as a practical objective, declaring with respect to this goal: "The search is on." Burgin suggests the example of a PC being used as a terminal to access a supercomputer with the supercomputer playing the role of oracle. For more on these matters, see the reviewer's *Myth of Hypercomputation* in "Alan Turing: Life and Legacy of a Great Thinker," Christof Teuscher, editor, Springer 2004.

In concluding, let the author have the last word: "Such misunderstanding of modern computers that restricts them to the conditions of the Church-Turing thesis is not unique and similar 'blindness' is not new in society. Thus, people thought for thousands of years that the Sun rotated around the Earth and only in the 16th century Copernicus proved different."

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TORKEL FRANZÉN. ***Gödel's theorem: an incomplete guide to its use and abuse.*** A K Peters, Ltd., Wellesley, Massachusetts, 2005, x + 172 pp.

The book under review opens up by a claim that "it is most likely safe to say that no mathematical theorem has aroused as much interest among non-mathematicians as Gödel's incompleteness theorem." Indeed, evidence for this can be clearly seen, for example, in various Internet discussion groups, and the call for the book according to the author emerged from his involvement in those Internet discussions over the last few years. (Another piece of evidence for the fame of Gödel outside mathematics is that he was pronounced the best mathematician of the XX-th century in the millennium issue of ***Time*** magazine. Whereas we, logicians, feel very proud for the honor awarded to one of our greatest, in truth we could hardly count on the same outcome of the vote had the poll been done within the mathematical community.)

As a consequence of this popular appeal, hardly any other mathematical result is surrounded by so many misconceptions, misapplications, abuses and outright nonsense. Torkel Franzén sets out to clean up this mess. He presents Gödel's incompleteness theorems in a way accessible to a sufficiently general audience, but most importantly he comments extensively on the many aspects and issues involved with Gödel's result. He analyzes the most common mistakes, groups them thematically, and points a finger at exactly where the problem is in each case. These comments are the main novelty of the book and as far as I know make it truly unique.

Given the amount of published popular expositions of Gödel's theorems (perhaps the first that come to mind are the books by Raymond Smullyan), and given the amount of interest in Gödel's theorems, one wonders why such a book has never appeared before. Apparently, mathematically oriented logicians were interested in accessibly presenting the *technical* details of Gödel's proof in the first place. Discussing the meaning and possible (mis)interpretations of the results lies outside the tradition of mathematical textbooks. Those books usually let the results, so to say, speak for themselves. Mathematicians also rarely devote extended texts to discussions of errors—unless a correction of an error amounts to a mathematical result on its own.

A profound discussion of Gödel's results requires both a truly deep mathematical understanding of these results *and* a good qualification in philosophy. For, such a discussion can only be a discussion coached in non-mathematical terms with a kind of attention to the meanings of terms typical for texts in philosophy. This combination is, in fact, rare. So, the task that Torkel Franzén set out to do was by no means an easy one. But what a remarkable result!

In a fairly short text he managed to comment on almost every significant aspect of Gödel's Theorems (GT) and its uses. To give the reader an idea let me mention some—there are many more—of the questions addressed:

- Does GT imply that there are 'unprovable truths'?
- Does GT put all mathematics in doubt (for fear of contradictions)?
- Has the 'complexity' of an axiom system anything to do with the incompleteness phenomenon?
- Does GT imply the impossibility of TOE (the hypothetical Theory Of Everything in physics)?
- Does GT imply any limitations of human thought?
- Does GT imply the impossibility of artificial intelligence (humans are not machines)?

The book is written in a lively readable style, but at the same time the author's comments are exceptionally clear, accurate and very much to the point. This style of presentation allowed him to expose the many fallacies surrounding Gödel's results in a truly convincing way.

There are a couple of topics related to GT that have already provoked a lot of discussion in the literature. The book, of course, could not avoid it. Thus, it gives a fair criticism of Lukas's and Penrose's arguments supporting the anti-mechanist thesis (the last question of the list above). Another topic is Gregory Chaitin's proof of GT using Kolmogorov(/Solomonoff/Chaitin) complexity. This topic is broadly propagandized by Chaitin in a number of popular books, and it is also surrounded by doubtful general claims. The reader will find a thorough discussion of Chaitin's approach here as well.

Curiously, there are not so many comments on the famous book by Douglas Hofstadter. In fact, Torkel Franzén—quite appropriately—has nothing against using GT as a metaphor or as a source of intellectual inspiration.

Reading all this body of material on misuses of GT in accumulated form creates an impression that, in fact, GT has literally *no* correct use outside its formal logical and mathematical context. Strictly speaking, this may be true. But perhaps the author should have given a bit more emphasis on the *real* importance of GT, lest the reader gets totally disillusioned with, in fact, an amazing result and a jewel of logic. For example, one could have stressed the role GT historically played in developing the theory of computation.

I am truly impressed by this enjoyable and useful book. After having read it did my own perspective on GT change? Well, most of the things the author said were commonsense, very well known in the community of professionals. But, on the other hand, I believe many such things were explicitly put on paper for the first time here and the author did it in a very successful way.

PS. After having been in occasional e-mail correspondence with Torkel Franzén for some years, I hoped to meet him in person for the first time at the Kurt Gödel Centennary conference in Vienna in 2006, where he accepted the honorable invitation to speak. These plans never materialized as the news came of his untimely death. Still, his two published books remain with us, for which I am grateful.

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SERGIO GALVAN. ***Einführung in die Unvollständigkeitstheoreme.*** Mentis, Paderborn, 2006, 167 pp.

The book under review is a German translation of Sergio Galvan's ***Introduzione ai Teoremi di Incompletezza***, F. Angeli, Milano, 1992. It is divided into six chapters. The first four chapters focus on the technical side of Gödel's Theorems. The concept of a formal theory is introduced, and its axiomatization is exemplified by first-order predicate calculus with identity (Chapter 0). After this, the language of Primitive Recursive Arithmetic (PRA) is elaborated, its arithmetization is presented, and the derivability conditions are formulated (Chapters 1–3). In Chapter 4 the proofs of Gödel's Theorems are outlined. The technical exposition of the diagonal lemma, Löb's Theorem and ω-inconsistency are given. Chapter 5 aims at clarifying the impact of Gödel's Theorems on Hilbert's Program and its epistemological implications in general.

Galvan comes to the following results: Firstly, Gödel's Theorems refute Hilbert's Program, which calls for a formalization of all mathematics in axiomatic form, together with a finitary proof that this axiomatization of mathematics is consistent. Secondly, Gödel's Theorems show that an absolute foundation of our knowledge is impossible. Nevertheless, a foundation is still possible, if understood in a relative and conditional sense. With regard to the structure and origin of (mathematical) knowledge, the author draws the conclusion that a priori knowledge is indispensible, i.e., a conceptual intuition, based on reason and intellect. From a Kantian perspective the author criticizes logicism and reductive instrumentalism.

Although the book offers a detailed a technical introduction and a sophisticated philosophical interpretation of Gödel's Theorems, it is not beyond dispute. However, it is not beyond dispute. Like Georg Kreisel, Craig A. Smorynski et al., the author presupposes the equivalence of the consistency program with the program of the conservative extension of finitistic mathematics, based on the so-called reflection principles. The author restricts the reflection scheme to Π^0_1-sentences, presupposing that Hilbert's real sentences coincide with Π^0_1-sentences and PRA with the finitistic part of mathematics Hilbert had in mind. This approach is an interesting rational reconstruction of Hilbert's finitistic position. Nevertheless, the presuppositions are problematic. Neither Hilbert nor Bernays nor other collaborators ever claimed that only primitive recursive operations count as finitary. Moreover, they used methods which go beyond the primitive recursive and accepted them as finitary.

From a philosophical point of view, Galvan's thesis, that the failure of Hilbert's Program was the clearest *proof* for the indispensibility of conceptual intuition, seems to be too strong. Gödel's Theorems per se do not force one to adopt any specific philosophical position. From a historical point of view, one should evaluate Galvan's reconstruction of Hilbert's Program critically, because finitary proof theory was only one part of Hilbert's wide-ranging project, and even today, scholars are not entirely clear on the meaning of Hilbertian finitism. Recent studies have thrown new light on the historical background and development of Hilbert's Program (see Michael Detlefsen, Paolo Mancosu, Volker Peckhaus, Panu Raatikainen, Wilfried Sieg, Richard Zach et al.). In addition there is recent logical and systematic research (see Solomon Feferman, Harvey Friedman et al.) that call the general view into question that Gödel's results have buried Hilbert's Program. Galvan's book takes no notice of them.

At least, one should complain that the very short bibliography is out of date (Apart from Hilbert's and Bernay's ***Grundlagen der Mathematik***, only one work by Hilbert is cited, the Italian translation ***Ricerche sui fondamenti della matematica***, and not even one work by Gödel is listed.) Last, but not least, one peculiarity in the translation has to be mentioned. In the Italian original the author speaks about *dimonstrazione della coerenza*, respectively *programma della coerenza*, i.e., *consistency proof* in English. It remains unclear why the Italian term is translated into German by using the new expression *Kohärenzbeweis* instead of using the word *Widerspruchsfreiheitsbeweis*. Despite these slight drawbacks, the German translation of Galvan's book offers a solid survey of Gödel's Incompleteness Theorems. But, from my point of view, a translation fifteen years after the publication of the Italian original seems to be rather late.

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ANDERS KOCK. ***Synthetic differential geometry.*** 2nd edition, London Mathematical Society Lecture Note Series, vol. 333. Cambridge University Press, 2006, xii + 233 pp.

The past half-century has seen a remarkable revival of the concept of infinitesimal, a concept which had formerly been thought (as far as its use in analysis and geometry was concerned, at least) to be thoroughly exploded. The publication in 1966 of Abraham Robinson's ***Non-Standard Analysis*** was the first stage in the rehabilitation of the infinitesimal concept. Robinson's infinitesimals may be considered "ideal" elements added to the usual real numbers, obeying the same algebraic (and logical) rules. A few years later the second and more radical stage in the rehabilitation of infinitesimals took shape with the bringing to fruition of the idea—originating with F. W. Lawvere, and developed by him and Anders Kock—of using category theory to construct a framework—modelled by a certain kind of *elementary topos*—within which analysis and differential geometry can be developed using the concept of *nilpotent* infinitesimal. Here by the latter is meant a quantity so "small" that some power of it (most usefully the square), and so all higher powers, can be set, literally, to zero. This framework, known as *synthetic differential geometry* or *smooth infinitesimal analysis*, can be considered a description of a mathematical universe in which all correlations between mathematical objects are smooth (i.e., arbitrarily many times differentiable).

A central notion of SDG is that of an *infinitesimal tangent vector*. A tangent vector to a curve C at a point p on it is a short straight line segment λ around p pointing along C. In SDG we can take λ to be a *part* of C. If one takes C to be the parabola $y = x^2$ and p to be the origin, then the corresponding λ (which we write as Δ) consists of the points x on the real line for which $x^2 = 0$, the *nilsquare infinitesimals*. In SDG, Δ is subject to the *Kock–Lawvere axiom* or the *principle of microaffineness*. This asserts that all real-valued maps on Δ are affine, and may be paraphrased by saying that Δ remains straight and unbroken under any transformation: it is, so to speak, too small to bend or break. Yet the principle of microaffineness guarantees that Δ is nondegenerate, that is, not identical with $\{0\}$.

These facts enable differential geometry and the calculus to be developed within SDG in an extremely straightforward way. For example, a *tangent vector* at a point p of a space (or "manifold") M is an infinitesimal straight path on M passing through p, that is, a map $\rho\colon \Delta \to M$ with $\rho(0) = p$. So the *tangent bundle* of M is just M^Δ, the space of all maps $\Delta \to M$, and a *vector field* on M any map $M \to M^\Delta$ whose composite with the base point map $\rho \mapsto \rho(0)\colon M^\Delta \to M$ is the identity on M. This is just the beginning of the remarkable conceptual simplification of differential geometry made possible by SDG.

It should be noted that the pervasive nature of continuity in SDG forces connected spaces such as the real line $\mathbf{R}$ to be *indecomposable* in the sense of not being splittable into two disjoint nonempty parts. It immediately follows that the laws of excluded middle and double negation of classical logic must *fail* in SDG; in fact the "internal logic" of SDG, like that of all toposes, is *intuitionistic* or *constructive*. (But the failure of classical logic in SDG is hardly noticed for most "practical" purposes because reasoning in basic differential geometry and calculus is essentially constructive in the first place.) The failure of the law of double negation has been exploited in a striking way in certain models of SDG, where infinitesimal real numbers can be identified either as nilpotent elements or as elements *not unequal to* or *indistinguishable from* 0. In this situation, one can say that two points are *infinitesimally close* if they are not unequal, or indistinguishable; the assertion that all maps are continuous then reduces to the purely *logical* fact that any map automatically preserves the relation of indistinguishablity. Here we have a remarkable reduction of topology to logic.

The first edition of Kock's book, published in 1981, but long out of print, introduced the subject of synthetic differential geometry to the mathematical public. It covered most of the basic concepts and theorems of SDG, and included sections on categorical logic and models of SDG. This second edition is largely a retyping in TEX of the first edition; also included are a number of comments on more recent developments in the field, as well as an updated bibliography. It is always a pleasure to see a classic work back in print, and this is no exception.

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MARK VOROBEJ. ***A Theory of Argument.*** Cambridge University Press, Cambridge, 2006, x + 324 pp.

A ***Theory of Argument*** is a textbook written for undergraduate students who have completed a prior course in logic, whether it be formal logic, informal logic, critical thinking, or argumentation theory. Although it is intended to be a textbook, it does develop its own individual theory of argument interpretation and evaluation, and therefore is of interest as a scholarly contribution to the fields of logic and argumentation theory. The book is divided into two parts. The first part develops a theory of argument cogency, while the second part offers an account of argument diagramming.

The notion of argument is defined around the idea of a dialogue exchange in which one party attempts to convince another to do or believe something by offering reasons. The arguer's audience is the person or persons to whom his or her argument was directed. Along these lines, an argument is therefore defined on the author's view as an attempt at rational persuasion (p. 3). Rational persuasion is best achieved, according to the author, by use of a cogent argument, an argument by which you (the audience) ought to be persuaded (p. 47). Cogency is defined by four requirements (p. 49). The first requirement is that it is rational for you to believe of each premise within the argument that it is true (p. 49). According to the second requirement, one proposition is said to be relevant to another just in case the truth of the one would provide evidence in favor of the truth of the other (p. 50). According to the third requirement, a set of proposition grounds a single proposition just in case, were all the propositions in the set true, together they would provide enough evidence in support of the single proposition to justify believing it is true (p. 50). According to the fourth requirement, an argument is compact just in case each proper subset of its premises provides less evidential support for its conclusion than does the set itself (p. 51). Note that according to this model, it's possible for a cogent argument to have false premises. An argument can be cogent as long as a careful review of the evidence gives no reason to think that a premise is false. Let's call this model the cogent argument model.

The cogent argument model is somewhat out of synchronization with the mainstream of argumentation theory, where the commitment model (Charles L. Hamblin, ***Fallacies***, Methuen, London, 1970), is widely accepted. In the Hamblin model, an argument is defined as a sequence of moves in a dialogue. On this model, premise acceptance is based on the notion of commitment. As a dialogue between two arguers proceeds, each of them takes turns making moves, nowadays called speech acts, and rules govern how statements are added to our retracted from what is called a commitment store (Hamblin, 1970). According to the opposed model, called the BDI (belief-desire-intention) model, premise acceptance is defined in terms of belief, as opposed to commitment. A commitment is merely a statement that a participant in a dialogue has gone on record as accepting, in virtue of what he or she said, or in virtue of what can be inferred from that by the commitment rules. The cogent argument model above clearly fits into the BDI category.

Because this book is based on a particular theory of argument, there are likely to be differences of opinions among potential adopters of the book for use in their classes. For these reasons, those who accept the BDI model will be inclined to like, or at least be friendly to the cogent argument model on which this textbook is based. For those who like the commitment model, the textbook may not be all that useful, or at least those who have adopted this model may not be too friendly to its approach.

Argument diagramming has become an important skill to teach in courses on argumentation and critical thinking. The typical argument diagram is a graph structure that is amenable to formalization. Currently, formal models, and even automated systems of argument diagramming are being developed. Therefore argument diagramming is also of interest to formal logicians, computer scientists (especially in artificial intelligence) and argument theorists. Diagramming is no longer merely a practical tool to help teach skills of critical thinking and argument analysis to students. The second part of the book, on argument diagramming, makes some original points as a contribution to this field. The part on diagramming could also be a very useful section of the book for teaching students argumentation skills. The diagramming system used is to some extent standard, drawing a distinction between linked and convergent arguments. In other respects, however, the diagramming system is nonstandard, using squiggly nodes, as they're called (p. 200), in addition to regular nodes in an argument diagram. The squiggly nodes are meant to indicate that an argument's author is confused or mistaken, or that some cognitive dissonance obtains between the author and her audience. This approach is very interesting and innovative from a theoretical point of view. However, since it is nonstandard, those who are considering using this textbook should decide how well they like this feature before adopting it.

The book is skillfully written, with careful attention to detail, and can be highly recommended, either as a textbook that will be found useful for the purposes it was designed to fulfill, or as an interesting approach to theory of argument.

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J. Flum and M. Grohe. ***Parameterized complexity theory.*** Texts in Theoretical Computer Science. Springer, Berlin, 2006, xiii + 493 pp.

Why is there a review on a book about Parameterized Complexity Theory in the Bulletin of the ASL? Because one of the main messages of this book is that model checking for first-order logic is at the very heart of parameterized "intractability" theory. Before we get into that, let me give a quick introduction to the topic for the reader who has not yet heard much about parameterized complexity.

Some computational complexity results appear counterintuitive, at first sight: as an example, deciding whether a given LTL formula φ holds in a given Kripke structure A is complete for **PSPACE** . Seemingly, this contradicts the every day experience that the task can be performed efficiently in practice. A first—well-known—explanation is that usually φ is much smaller than the structure and that the overall complexity is "bad" only in the size of φ. In particular, if the *parameter* "size of φ" is bounded by a constant, model checking is doable in polynomial time.

Nevertheless, this explanation is not very precise as a comparison with another well-known algorithmic problem shows: the CLIQUE-problem asks, given a graph G and a number k, whether G has a complete subgraph of size k. Just as for LTL model checking, the complexity of CLIQUE is possible in polynomial time if the parameter k is fixed. But there is a difference between the two problems: the straightforward algorithm for CLIQUE needs about n^k steps for graphs with n nodes, which is unfeasible even for moderate sizes of k, e.g., $k = 10$. So far, there are no significantly better algorithms. In contrast, the LTL model checking problem can be solved in time $O(k2^{2k}n)$, where k is the size of φ and n the size of A. The crucial difference is that, here, the "exponential part" of the complexity does only depend on the parameter but not on the full input size. As introduced by Downey and Fellows in the early nineties, a *parameterized problem*, i.e., a set of parameterized instances of the form (x, k), is called *fixed-parameter tractable* if it has an algorithm of complexity at most $f(k)p(|x|)$, where p is a polynomial and the only requirement for f is computability. Thus, the LTL model checking problem, parameterized by the size of φ, is fixed-parameter tractable.

Given this relaxed notion of tractability, there are two natural directions for research: (1) to identify more tractable problems and find ever better algorithms for them (*Fixed-Parameter Algorithms*) and (2) to classify intractable problems with respect to their degree of intractability (*Parameterized Complexity Theory*).

The book of Flum and Grohe covers both directions with a clear focus on the latter. It basically consists of three main parts:

- Chapters 2–8 give a comprehensive introduction to Parameterized Complexity Theory.
- Chapters 9–13 present results on and techniques for Fixed-Parameter Algorithms.
- Finally, Chapter 14 addresses the parameterized complexity of counting problems and Chapters 15 and 16 study the *bounded* setting of parameterized complexity where the function f is restricted to exponential or below.

Parameterized Complexity Theory is a complicated matter: the parameterized counterparts of **NP**-complete problems give rise to many different equivalence classes with respect to *parameterized* reductions. Thus, the landscape of classes of presumably intractable problems is much more diverse than in classical Complexity Theory. However, this can be seen as a feature, as it yields a fine-grained classification of hard problems in the classical sense. It is less favourable, though, that the machine based definitions of these intractable classes are usually not very intuitive, therefore it is common to define them as equivalence classes of characteristic problems.

The specific approach taken by Flum and Grohe—in the book and in their preceding research—is to stress the relationship of the most important parameterized classes with fundamental algorithmic problems of logic: model checking for first-order logic (on input a structure and a formula) and checking for properties defined by (fixed) existential second-order formulas (given a structure as input).

As an example, one of the central results is that the classes $W[t]$ of the W-hierarchy correspond to the model checking problem for Σ_t formulas where all quantifier blocks besides the first one are of length 1 (or any other constant length). Without this restriction, model checking for Σ_t corresponds to the class $A[t]$, giving rise to another interesting hierarchy invented by the authors.

Actually, the A-hierarchy helps the authors to achieve one of the main enjoyable features of the book: it allows to draw a structured and simplified picture of the class landscape (thus making Figure 8.2 on page 193 the most consulted item in my copy): above the class **FPT** of fixed-parameter tractable problems, there are basically the two mentioned hierarchies, each of which is supplemented by two classes on top, one based on formulas without quantifier restrictions and one on circuits. The W-strand consists of classes in **NP** whereas the A-strand goes beyond that: the A-hierarchy intuitively corresponds to the polynomial hierarchy and the upper classes to polynomial space. Each of the classes matches the complexity of a logical problem and most of them also have a machine characterization.

The choice of topics in the algorithmic part of the book is clearly biased by the numerous contributions of the authors to the field. From the point of view of Logic chapters 10 and 11 are the most interesting. Chapter 10 is about the automata-theoretic approach and particularly presents exciting lower bound results on the growth of f for every fixed-parameter algorithm for Model Checking monadic second-order (MSO) formulas on trees. Chapter 11 deals with parametrizations by the tree-width of structures, culminating in Courcelle's Theorem that the evaluation of MSO formulas is fixed-parameter tractable.

How does the book compare to others in the area? ***Parameterized Complexity*** by Downey and Fellows was the first book, written by the pioneers of the fixed-parameter approach. It gave a pretty complete account of the state of the art when it appeared in 1997, but it could hardly be considered a textbook. About ten years later, the field has developed considerably, partly thanks to the research of Flum and Grohe themselves. Their book covers the current knowledge but, despite the remaining technical difficulty of the matter, it is also the first textbook on Parameterized Complexity Theory.

Readers solely interested in Fixed-Parameter Algorithms might also consider the nice recent book of Rolf Niedermeier, ***Invitation to Fixed-Parameter Algorithms***. It addresses Parameterized Complexity Theory only in one chapter, not stressing the connection to Logic, but giving a less technical introduction to algorithmic techniques.

Summarizing, the book by Flum and Grohe is an excellent source for everyone interested in a comprehensive up-to-date view of Parameterized Complexity. It should not be missing on the shelf of any researcher interested in Logic and Complexity Theory and anyone intending to teach a course covering a significant part of Parameterized Complexity Theory.

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Handbook of philosophical logic, edited by D. M. Gabbay and F. Guenthner, vol. 10. Kluwer Acadamic Publishers, Dordrecht/Boston/London, 2004, 361 pp.—therein:

JOHN-JULES CH. MEYER. *Modal epistemic and doxastic logic*. Pp. 1–38.

NATHAN SALMON. *Reference and information content: names and descriptions*. Pp. 39–85.

GRAEME FORBES. *Indexicals*. Pp. 87–120.

RAINER BÄUERLE and M. J. CRESSWELL. *Propositional attitudes*. Pp. 121–141.

GEORGE BEALER and UWE MÖNNICH. *Property theories*. Pp. 143–248.

FRANCIS JEFFREY PELLETIER and LENHART K. SCHUBERT. *Mass expressions*. Pp. 249–335.

This volume of the second edition of the ***Handbook of philosophical logic*** consists of 6 articles: 4 shorter ones, and two of about 100 pages. Five of the articles occurred in some form in the first edition of the handbook (vol. IV). Below each of the articles is considered in detail.

John-Jules Ch. Meyer, Modal epistemic and doxastic logic.

In the last two decades the epistemic and doxastic logics found application in computer science and artificial intelligence, where they play an important role in understanding advanced software systems. The article gives an overview of the logical research done in this field. Subjects discussed are, for instance, minimal knowledge and the problem of omniscience. After the theory attention is given to applications such as distributed systems, common knowledge and intelligent agents. The article does not give information on the history of knowledge and belief in philosophical logic, nor does it discuss the solutions proposed there for the problem of logical omniscience (such as the ones discussed in this handbook by Bäuerle and Cresswell). The style is as is standard in mathematics: with explicit definitions and theorems, but little intuitive explanation. The article is newly written for this edition of the handbook, and it is a useful addition.

Nathan Salmon, Reference and information content: names and descriptions.

Declarative sentences bear various semantics aspects; they have for instance a truth value and an intension, but their fundamental semantic role is to encode information. The article investigates this latter aspect, in particular the contribution of terms (e.g., of 'Plato', or 'the author of *The republic*') to the information of the sentence. It discusses the naive referential theory (the 'Fido'-Fido theory), Frege's early theory, Mills' theory and Russell's theory, and explains their complications in a clarifying way.

The text is the same as in the first edition, and therefore only the traditional theories about sentences-in-isolation are considered. However, since the time of that publication, linguistic semantics has made considerable steps towards discourse. The notions 'information' and 'information change potential' play a central role there. Such modern developments are not considered: neither 'discourse representation theory' [J. van Eyck and H. Kamp, *Representing discourse in context*, in J. van Benthem and A. ter Meulen (editors), ***Handbook of logic and language***, Elsevier, Amsterdam, 1997, pp. 179–237] nor 'dynamic semantics' [J. Groenendijk and M. Stokhof, *Dynamic predicate logic*, Linguistics and Philosophy, 1991, pp. 39–100]. This remark should not be considered as a criticism of the author (because what not is, cannot be incorporated in an overview), but of the field. Philosophers seem not to be aware that their topics not only originate from other fields, but that there are developments in those fields which philosophy should incorporate, and questions on which philosophy should react.

Graeme Forbes, Indexicals.

Examples of indexicals are 'I', 'yesterday' and 'here'. The object associated with such an expression cannot be determined once and for all, it 'depends'. Forbes summarizes the problems and discusses some authors extensively, e.g., Peacocke and Davidson. In particular, he gives a detailed and very clear exposition of Kaplan's semantics because that is the most influential contribution to this topic.

This contribution has been completely revised with respect to the first edition: updated references, new arguments, references to other articles in this handbook, and many new arguments (e.g., on 'indexicals and the contingent a priori'). It is an exemplary handbook article.

Rainer Bäuerle and M. J. Cresswell, Propositional attitudes.

This article starts with some appealing problems, e.g., what is the object of Othello's belief in 'Othello believes that Desmona loves Cassio', in particular when Desmona does not love Cassio, and how the account for the difference between 'John believes that $2 + 2 = 4$' and 'John believes that $\sqrt{144} = 12$'. The article discusses three approaches to the latter problem: giving up compositionality, using structured meanings, and selecting an approach in which the two belief sentences above are equivalent (authors raise objections). It is a clear article with many interesting examples.

The article is a reprint of the original, with an added paragraph which mentions recent collections of articles on the topic. Authors state that most of these newer work belong to one of the approaches considered in the original text, and therefore need not be discussed. The article does not lay any connections with the work on knowledge and believe in theoretical computer science (see e.g. the first article of the present handbook, or R. Fagin, J. Y. Halpern, Y. Moses and M. Y. Vardi, ***Reasoning about knowledge***, The MIT Press, Cambridge Mass. 1995). So this is again an example showing that philosophers are not aware of developments in the neighboring fields.

George Bealer and Uwe Mönnich, Property theories.

In this large article (105 pages), the authors present and defend one particular approach to the semantic analysis of properties, viz. Bealer's. Many arguments are put forward, classical paradoxes are discussed, alternatives are refuted, and technical aspects of their solution are explained (a first order intensional logic of which a sound and complete axiomatization). Theories that do not fit into their line of argumentation (type-free theories with fixed points) are briefly mentioned in the last section, but not critically reviewed.

If a reader works through this article he will achieve a considerable knowledge of property theories. But if he is not familiar with the topic, it will be a difficult task. The article does not start with an overview of the problems, neither does it systematically discuss rival theories. The first natural example (i.e., without 'possibly' and 'necessarily') is given only after 34 pages: 'Seneca said that man is a rational animal', which is explained to differ in meaning with 'Seneca said "man is a rational animal"'. So the article throws the reader, as in a research article, immediately in at the deep end, and while studying he gradually may learn what the field is about.

The article is a slightly revised version of the original article: in footnotes some new references discussed. As in the first edition, authors state about the type-free setting: 'the mathematics that can be derived within them is rather week'. That is a remarkable statement in the light of the huge amount of research done in theoretical computer science where type-free theories constitute an important approach to semantics of programming languages [S. Abramsky, D. M. Gabbay and T. S. E. Maibaum, ***Handbook of logic in computer science***, Clarendon press, 1995, vol 3, ch. 1 and ch. 2].

Francis Jeffrey Pelletier and Lenhart K. Schubert, Mass expressions (pp. 249–335).

This large article (84 pages) deals with the meaning of mass expressions (e.g., 'water' and 'dirty water') and the differences with count expressions (e.g., 'person' and 'tall person'). The article provides an extensive discussion of proposals from the literature, explains the pro and con's of those approaches and argues that none is fully satisfactory. According to the authors, all approaches have one error in common: one asks what *the* meaning of a mass noun is, and fails to notice the ambiguity: the meaning of 'water' depends e.g., on whether it is a lexical entry, occurs in the sentence 'water is widespread' or in 'water is dirty'. There is a systematic relation between these different meanings, which can be described by type lifting rules as such are known in Montague Grammar and X-bar theory. Authors' view is presented very convincingly.

The contribution is a revision of the first edition. Authors kept the original text, but have updated it by inserting remarks on new developments, and they have added a useful section on mass expressions in the psychological research, computational linguistics and history of philosophy. They clearly are aware of developments in neighboring fields.

The publisher did his part of the job in a minimal way. The table of contents only mentions where the articles start, but not where sections and subsections start; hence the overview a table of contents normally gives, is missing. There is an index, but of low quality. The notions 'common knowledge' and 'distributed knowledge' are not found under 'knowledge', but only under 'c' and 'd' respectively. In the article on indexicals, Kaplan's logic plays an central role, but that did not lead to an entrance under 'Kaplan' nor under 'logic, Kaplan's '. The names from the bibliographies of the last two articles seem to arise systematically in the index, but that is, alas, not the case for the other articles (e.g., Partee and Peacocke do not arise at all). The article on mass nouns seems to be represented best because it even leads to the entries 'overlap', 'serving' and 'kinds of stuff'. The price of this book (348 pages) is €125 or $142.

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